



CLASS 12 · CBSE BIOLOGY (044)

Biology Solved Board Papers

Chapter-wise and year-wise CBSE board questions with complete step-by-step solutions

10 years · 2016–2026

- ✓ Part A: every question sorted chapter-wise, grouped by marks, with full solutions
- ✓ Part B: 17 complete board papers, each followed by its solutions
- ✓ Board weightage table and most-asked topics for every chapter
- ✓ Diagrams, crosses, flow charts and case-based answers written the way the board awards marks
- ✓ Only the current syllabus: questions on deleted topics are flagged

WHAT YOU GET

10 years of CBSE Biology papers. Every question solved. Sorted chapter-wise.

17

board papers

528

solved questions

10

years · 2016–26

13

chapters

37

diagrams

X Questions scattered across years



✓ All in one place, chapter-wise

X Don't know what to study first



✓ Weightage + most-asked topics

X One-line answers online



✓ Full solutions, board-style

X Old books carry deleted topics



✓ Only the 2026-27 syllabus

PART A**Chapter-wise****A**

- ✓ Weightage table
- ✓ Most-asked topics
- ✓ Every question + solution

PART B**Full papers****B**

- ✓ Exactly as set by CBSE
- ✓ Solutions after each paper
- ✓ Timed 3-hour practice

2026 · 57/1/1

2026 · 57/2/1

2025 · 57/4/1

2025 · 57/5/1

2024 · 57/1/1

2024 · 57/2/1

2023 · 57/1/1

2023 · 57/3/1

2022 · 57/2/1

2022 · 57/4/1

2020 · 57/1/1

2020 · 57/2/1

2019 · 57/2/1

2019 · 57/3/1

2018 · 57/1

2017 · 57/1

2016 · 57/1


Complete Notes · Solved PYQs

CLASS 6–12 · ALL SUBJECTS

100%
 QUESTIONS
 SOLVED
Made for **board toppers**

How to use this book

Part A puts every board question of a chapter together, from 1-mark MCQs to 5-mark long answers. Finish a chapter in your notes, then solve its Part A questions without looking at the solutions. Check your answer, mark the ones you got wrong, and repeat them a week later.

Each question shows where it was asked, for example **CBSE 2026 · 57/1/1 · Q13**. Use the weightage table and the most-asked topics chart at the start of each chapter to decide what to revise first.

Part B gives full papers. In the last month before the exam, sit with a clock and write one paper in 3 hours, then check it with the solutions that follow the paper.

Solutions are written the way the board awards marks: labelled diagrams, Punnett squares and crosses shown in full, key terms named, and each point kept short. Write your answers the same way.

Contents

Part A · Chapter-wise questions with solutions

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| 2. Human Reproduction 35 Qs | 8. Microbes in Human Welfare 39 Qs |
| 3. Reproductive Health 26 Qs | 9. Biotechnology: Principles and Processes 47 Qs |
| 4. Principles of Inheritance and Variation 52 Qs | 10. Biotechnology and its Applications 39 Qs |
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| 6. Evolution 35 Qs | 12. Ecosystem 22 Qs |
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Part B · Full board papers, each followed by its solutions

- | | |
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| 1. CBSE 2026 · 57/1/1 solutions | 9. CBSE 2022 · 57/2/1 solutions |
| 2. CBSE 2026 · 57/2/1 solutions | 10. CBSE 2022 · 57/4/1 solutions |
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| 5. CBSE 2024 · 57/1/1 solutions | 13. CBSE 2019 · 57/2/1 solutions |
| 6. CBSE 2024 · 57/2/1 solutions | 14. CBSE 2019 · 57/3/1 solutions |
| 7. CBSE 2023 · 57/1/1 solutions | 15. CBSE 2018 · 57/1 solutions |
| 8. CBSE 2023 · 57/3/1 solutions | 16. CBSE 2017 · 57/1 solutions |
| | 17. CBSE 2016 · 57/1 solutions |

528 questions in all. Questions are taken from the CBSE Class 12 Biology board papers and the solutions are our own, checked against the official marking schemes. Questions on topics deleted from the current syllabus (reproduction in organisms, strategies for enhancement in food production, environmental issues, organism and its environment, ecological succession, nutrient cycling and ecosystem services) are left out of Part A and marked in Part B.

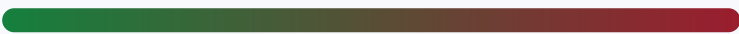
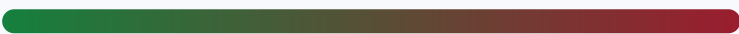
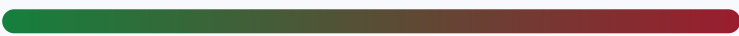
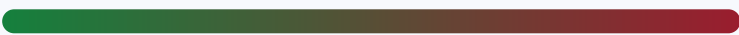
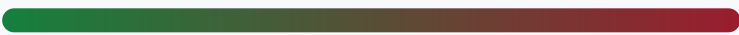
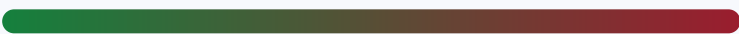
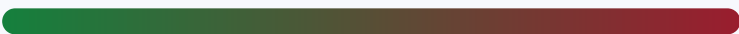
CHAPTER 1

Sexual Reproduction in Flowering Plants

Board weightage 2016–2026

Year	2016	2017	2018	2019	2020	2022	2023	2024	2025	2026
Questions	3	3	2	7	6	–	8	6	6	8
Marks	10	10	8	21	14	–	20	16	18	19

Most asked topics

Emasculation not needed		1
Seed dormancy; pea vs castor seed		1
Pollen viability and pollen banks		1
Diagram of the megasporangium		1
Divisions in embryo sac formation		1
Apomixis (A–R)		1
Wall layers of a microsporangium		1
Pollen–pistil interaction and double fertilisation		1

49 questions from 15 papers. Repeated questions are shown once with every year they were asked.

1 mark: MCQ and Assertion–Reason

CBSE 2026 · 57/1/1 · Q1

1 mark

Identify the plant in which emasculation is not required for artificial hybridization.

- (A) Rice
(C) Pea

- (B) Wheat
(D) Papaya

Solution

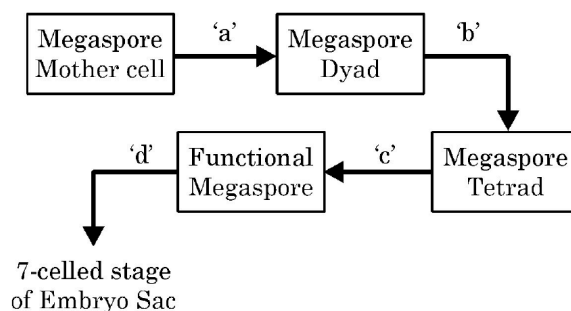
Answer: (D) Papaya

Papaya is dioecious: male and female flowers are on separate plants, so the female flower has no anthers to remove. It only needs bagging before pollination. Rice, wheat and pea have bisexual flowers and must be emasculated.

CBSE 2026 · 57/2/1 · Q10

1 mark

Given below are stages of embryo sac formation from megaspore mother cell. Identify the correct option for the cell division marked a, b, c and d.



(A) a – Meiosis-I, b – No division, c – Mitosis, d – Meiosis-II
 (C) a – Mitosis, b – Meiosis-I, c – Meiosis-II, d – No division

(B) a – Meiosis-I, b – Meiosis-II, c – No division, d – Mitosis
 (D) a – No division, b – Mitosis, c – Meiosis-I, d – Meiosis-II

Solution**Answer: (B)**

Meiosis I of the MMC gives a dyad, and meiosis II gives the tetrad of megaspores. Three megaspores then degenerate without division, leaving one functional megaspore. This megaspore divides by three rounds of free-nuclear mitosis to form the 8-nucleate, 7-celled embryo sac.

CBSE 2026 · 57/2/1 · Q13

1 mark

Assertion (A) : Apomixis leads to production of genetically identical off-springs.

Reason (R) : Apomixis involves fertilization between two genetically similar plants.

(A) Both A and R are true and R is the correct explanation of A. (B) Both A and R are true but R is not the correct explanation of A. (C) A is true but R is false. (D) A is false but R is true.

Solution**Answer: (C) A is true but R is false.**

Apomixis is the formation of seeds **without fertilisation** (an asexual process that mimics sexual reproduction), so the offspring are clones of the parent.

CBSE 2025 · 57/4/1 · Q6

1 mark

Select the statements that are true for a typical dicotyledonous embryo from the given options.

- (i) It consists of an embryonal axis and scutellum.
- (ii) The portion of embryonal axis above the level of cotyledon is epicotyl.
- (iii) The portion of embryonal axis below the level of cotyledon is coleorhiza.
- (iv) The lower end of the embryo has radicle covered with a root cap.

(A) (i) and (ii)

(B) (i) and (iii)

(C) (iii) and (iv)

(D) (ii) and (iv)

Solution**Answer: (D) (ii) and (iv)**

A dicot embryo has an embryonal axis and two cotyledons. The scutellum and the coleorhiza are features of a monocot (grass) embryo, and the part below the cotyledons is the hypocotyl.

CBSE 2025 · 57/5/1 · Q6

1 mark

Select the statements that are true for pollination mechanism in flowering plants from the given options.

- (i) In *Vallisneria*, the female flowers are pollinated by pollen grains inside the water.
- (ii) In *Zostera*, pollen grains are released on the surface of water.
- (iii) In most of the water-pollinated species, pollen grains are covered by a mucilaginous coating.
- (iv) Pollination by water is quite rare and limited to about 30 genera.

(A) (i) and (ii)

(B) (ii) and (iii)

(C) (iii) and (iv)

(D) (i) and (iv)

Solution**Answer: (C) (iii) and (iv)**

In *Vallisneria*, pollination happens on the surface of water. In sea-grasses such as *Zostera*, the female flowers stay submerged and the pollen is released inside the water.

CBSE 2024 · 57/1/1 · Q1

1 mark

In which of the following plants are both male and female flowers born on the same plant and the mode of pollination can be geitonogamy or xenogamy ?

(A) Papaya

(B) Date Palm

(C) Maize

(D) Spinach

Solution**Answer: (C) Maize**

Maize is monoecious, with unisexual male and female flowers on the same plant. Self-pollination (autogamy) is prevented, but geitonogamy and xenogamy are both possible. Papaya, date palm and spinach are dioecious.

CBSE 2024 · 57/2/1 · Q1

1 mark

An angiosperm embryo sac is located within the :

(A) Placenta

(B) Megasporangium

(C) Nucellus

(D) Ovary

Solution**Answer: (C) Nucellus**

The embryo sac (female gametophyte) develops from the functional megaspore inside the nucellus of the ovule.

CBSE 2023 · 57/1/1 · Q8

1 mark

Choose the option that gives the correct number of pollen grains that will be formed after 325 microspore mother cells undergo microsporogenesis.

- (a) 325 (b) 650
(c) 1300 (d) 975

Solution**Answer: (c) 1300**

Each microspore mother cell divides by meiosis into a tetrad of four microspores (pollen grains):
 $325 \times 4 = 1300$.

CBSE 2023 · 57/1/1 · Q15

1 mark

Assertion (A) : Endosperm is completely consumed during the development of embryo in ex-albuminous seeds.

Reason (R) : Castor, pea and beans are all examples of ex-albuminous seeds.

(A) Both A and R are true and R is the correct explanation of A. (B) Both A and R are true but R is not the correct explanation of A. (C) A is true but R is false. (D) A is false but R is true.

Solution**Answer: (c) A is true but R is false.**

Pea and beans are ex-albuminous, but **castor** is albuminous: part of its endosperm remains in the seed.

CBSE 2023 · 57/3/1 · Q6

1 mark

Which of the following seeds have remained alive for the longest period ?

- (a) *Phoenix dactylifera* (b) *Striga asiatica*
(c) *Mangifera indica* (d) *Yucca gigantea*

Solution**Answer: (a) *Phoenix dactylifera***

A 2000-year-old viable seed of the date palm was found during excavation at King Herod's palace near the Dead Sea. (Lupine seeds dug from Arctic tundra germinated after an estimated 10,000 years of dormancy.)

CBSE 2020 · 57/1/1 · Q2(a)

1 mark

Self-pollination is fully ensured if

- (A) the flower is bisexual. (B) the style is longer than the filament.
(C) the flower is cleistogamous. (D) the time of pistil and anther maturity is different.

Solution**Answer: (C) the flower is cleistogamous.**

Cleistogamous flowers never open, so the anthers dehisce close to the stigma and only self-pollen can reach it (assured seed set).

CBSE 2020 · 57/2/1 · Q1(a)

1 mark

Cleistogamous flowers are self-pollinated because

- (A) they are bisexual flowers which do not open at all.
(C) they are unisexual.

- (B) they are bisexual and open flowers.
(D) their stigma matures before the anthers dehisce.

Solution

Answer: (A)

Cleistogamous flowers never open, so only self-pollen can reach the stigma (e.g. *Viola*, *Oxalis*, *Commelina*).

2 marks: very short answer

CBSE 2026 · 57/1/1 · Q18(a)

2 marks

- (i) How does a farmer use dormancy of seed to his advantage ?
(ii) Differentiate between pea seed and castor seed.

Solution

(i) Dormant, dehydrated seeds can be stored for a long time. The farmer stores them and sows them to raise the crop in the next season (they are also used as food).

(ii)

Pea seed	Castor seed
Non-albuminous (non-endospermic)	Albuminous (endospermic)
The endosperm is fully used up during embryo development; no endosperm is left	A part of the endosperm is left in the mature seed

CBSE 2024 · 57/1/1 · Q17

2 marks

Identify A, B, C and D in the table given below :

Terms	Part of the plant it represents
Pericarp	'A'
'B'	Cotyledon in seed of grass family
Embryonal axis	'C'
'D'	Remains of nucellus in a seed

Solution

A – wall of the fruit (wall of the ripened ovary)

B – **scutellum**

C – the axis of the embryo that bears the radicle and plumule (epicotyl and hypocotyl)

D – **perisperm** (residual, persistent nucellus, e.g. black pepper, beet)

CBSE 2024 · 57/2/1 · Q17(b)

2 marks

Name any two outbreeding devices that flowering plants have developed and explain how they help in encouraging cross-pollination.

Solution

Any two:

- **Non-synchronised pollen release and stigma receptivity:** either the pollen is released before the stigma becomes receptive, or the stigma becomes receptive much before the pollen is released, so self-pollen cannot fertilise.
- **Different positions of anther and stigma:** the pollen cannot reach the stigma of the same flower.
- **Self-incompatibility:** a genetic mechanism that stops self-pollen from fertilising the ovules by inhibiting pollen germination or pollen-tube growth in the pistil.
- **Unisexual flowers:** production of unisexual flowers prevents autogamy (and dioecy, as in papaya, prevents geitonogamy too).

CBSE 2023 · 57/1/1 · Q18

2 marks

(a) From which end of the ovule, and how does the pollen tube gain its entry into the embryo sac of a *Hibiscus* flower ?

(b) State the fate of the male nuclei present in the pollen tube.

Solution

(a) It enters through the **micropylar end** (micropyle). It then enters one of the **synergids**, guided by the **filiform apparatus**.

(b) One male nucleus fuses with the egg nucleus to form the **zygote** (syngamy). The other fuses with the two polar nuclei to form the **primary endosperm nucleus** (triple fusion).

CBSE 2023 · 57/3/1 · Q17

2 marks

(a) Explain the process of the development of a male gametophyte in an angiosperm.

(b) Why is it called a male gametophyte ?

Solution

(a) Each cell of the sporogenous tissue (microspore mother cell, PMC) in the anther divides by **meiosis** into a tetrad of four microspores. As the anther matures and dehydrates, the microspores separate and develop into **pollen grains**. Inside each, mitosis forms a large vegetative cell and a small generative cell.

(b) The pollen grain is haploid and forms the male gametes: its generative cell divides to form **two male gametes**. So it represents the male gametophyte.

CBSE 2019 · 57/2/1 · Q7

2 marks

(a) You are given castor and bean seeds. Which one of the two would you select to observe the endosperm ?

(b) The development of endosperm precedes that of embryo in plants. Justify.

Solution

(a) **Castor**. It is albuminous: part of its endosperm remains in the mature seed. In bean (non-albuminous), the endosperm is fully used up by the embryo.

(b) The endosperm stores reserve food and **provides nutrition to the developing embryo**, so it must develop first.

CBSE 2019 · 57/3/1 · Q6

2 marks

(a) List any two characteristic features of wheat flowers that make it a good example of wind pollination.

(b) It is observed that plant breeders carrying out wheat hybridisation often take pollen grains from the 'pollen banks'. Do you agree ? Give one reason in support of your answer.

Solution

(a) Any two: light, non-sticky pollen produced in large numbers; well-exposed stamens; large, feathery stigma; a single ovule in each ovary; numerous flowers packed into an inflorescence.

(b) **Yes**. Wheat pollen loses viability within about **30 minutes** of release. Pollen stored in pollen banks by cryopreservation (liquid nitrogen, -196°C) stays viable for years and can be used whenever needed.

CBSE 2017 · 57/1 · Q6

2 marks

A pollen grain in angiosperm at the time of dehiscence from an anther could be 2-celled or 3-celled. Explain. How are the cells placed within the pollen grain when shed at a 2-celled stage?

Solution

In over 60% of angiosperms, pollen is shed at the **2-celled stage** (vegetative cell + generative cell). In the remaining species, the generative cell divides mitotically into **two male gametes** before the pollen is shed, so it is shed at the **3-celled stage**.

At the 2-celled stage, the **vegetative cell** is bigger, with abundant food reserve and a large irregular nucleus. The **generative cell** is small and spindle-shaped, with dense cytoplasm and a nucleus, and it **floats in the cytoplasm of the vegetative cell**.

CBSE 2016 · 57/1 · Q6

2 marks

A single pea plant in your kitchen garden produces pods with viable seeds, but the individual papaya plant does not. Explain.

Solution

- **Pea** has bisexual flowers and is self-pollinated (even cleistogamous). A single plant can pollinate itself and produce pods with viable seeds.

- **Papaya is dioecious:** male and female flowers are on separate plants. A single papaya plant is either male (no fruit at all) or female, which needs pollen from a male plant. With no cross-pollination, it cannot produce viable seeds.

3 marks: short answer

CBSE 2026 · 57/1/1 · Q22

3 marks

- (a) Do all pollen grains remain viable for the same length of time ? Support your answer with two suitable examples.
- (b) How are pollen grains stored in pollen banks ?

Solution

- (a) **No.** The period of viability varies a lot and depends on temperature and humidity.
- In rice and wheat (cereals), pollen loses viability within **30 minutes** of release.
 - In some members of Rosaceae, Leguminosae and Solanaceae, pollen stays viable for **months**.
- (b) Pollen is stored by **cryopreservation** in liquid nitrogen at **-196 °C** and used later in crop breeding programmes.

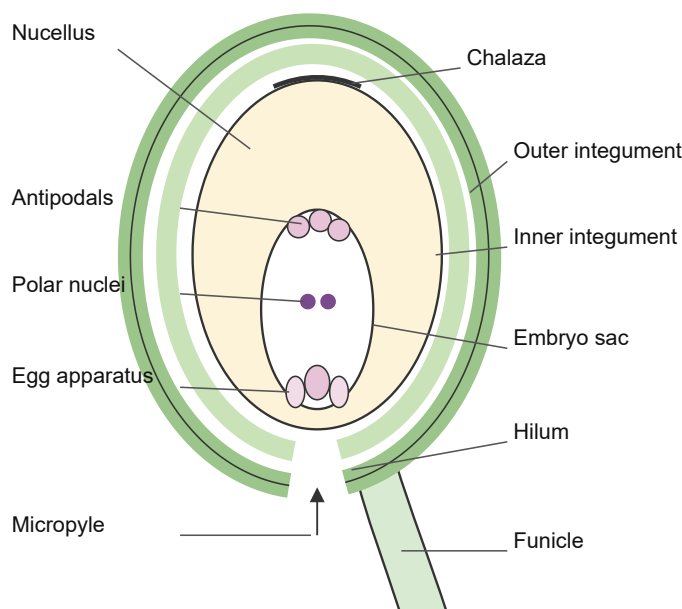
CBSE 2026 · 57/1/1 · Q25

3 marks

Draw a neat diagram of megasporangium of an angiosperm and label any six parts.

Solution

The megasporangium is the ovule (anatropous ovule, L.S.):

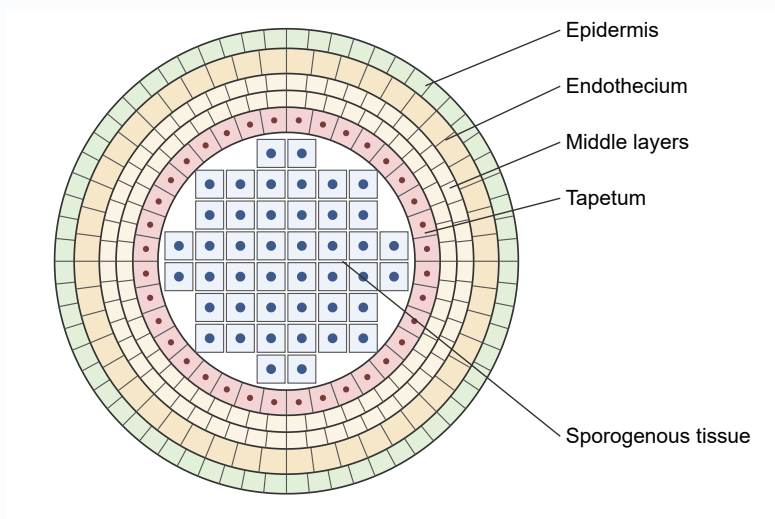


Any six labels: funicle, hilum, micropyle, outer integument, inner integument, nucellus, chalaza, embryo sac (egg apparatus, polar nuclei, antipodals).

CBSE 2026 · 57/2/1 · Q24

3 marks

Draw a neat diagram of enlarged view of one microsporangium of a Young anther of an angiosperm. Label the different layers of the wall and write the functions of the outermost and innermost layer.

Solution

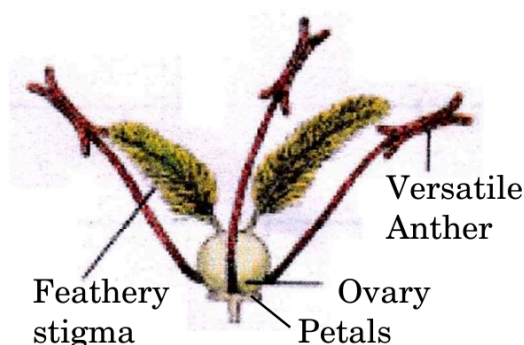
Wall layers from outside in: **epidermis**, **endothecium**, **middle layers**, **tapetum**. The centre holds the sporogenous tissue.

- Outermost layer, the **epidermis**: protects the anther and helps in its dehiscence to release the pollen.
- Innermost layer, the **tapetum**: nourishes the developing pollen grains. Its cells have dense cytoplasm and often more than one nucleus.

CBSE 2025 · 57/4/1 · Q26

3 marks

Given below is a flower with its characteristic features specialised for the most common type of abiotic pollination.



Answer the following questions based on the above diagram :

- Name the mode of abiotic pollination that will be adopted by the given plant species in the above picture.
- State the need of exposed large feathery stigmas for the flower.
- What will be the two important adaptations in the pollen grains of the flowers pollinated by the above mode of pollination ?
- What could be the probable reason for the petals being small and non-green ?

Solution

(a) **Wind pollination (anemophily).**

(b) Large, feathery, exposed stigmas **trap the air-borne pollen** grains easily.

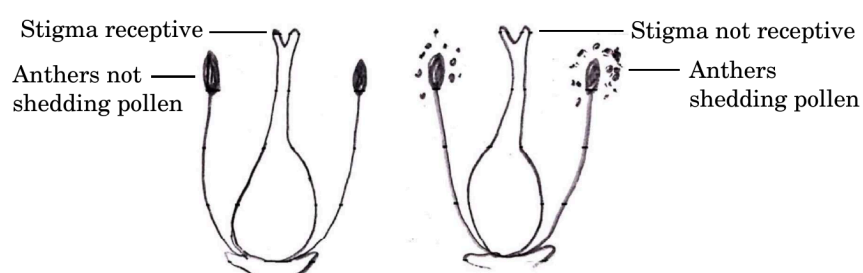
(c) The pollen grains are **light** and **non-sticky**, so they can be carried by wind (and they are produced in very large numbers).

(d) Wind-pollinated flowers need not attract insects, birds or bats, so they have no colourful petals, nectar or scent. Small petals also do not block the flow of wind and pollen.

CBSE 2025 · 57/5/1 · Q28

3 marks

Many of the flowering plants producing hermaphrodite flowers have developed many devices to discourage self-pollination and to encourage cross-pollination. Given below is a picture of one such outbreeding device in a flowering plant. Study the picture and answer the questions that follow :



Flowers present on different plants of same species

(a) Explain how the given type of pollination is advantageous to the plant.

(b) Can this flowering plant show geitonogamy ? Justify your answer.

Solution

The picture shows that pollen release and stigma receptivity are **not synchronised** (dichogamy), so pollen must come from a flower on another plant (cross-pollination, xenogamy).

(a) Cross-pollination brings genetically different pollen. This **prevents inbreeding depression**, keeps the plant vigorous and fertile (hybrid vigour), and increases genetic variability, which helps adaptation.

(b) **No.** Geitonogamy is transfer of pollen to the stigma of another flower on the **same plant**.

Here, when the stigma of a flower is receptive, the anthers on that plant are not shedding pollen, and the pollen comes from flowers on different plants. So only xenogamy is possible.

CBSE 2023 · 57/1/1 · Q28(b)

3 marks

Differentiate between the following : (i) Perisperm and Pericarp (ii) Syncarpous pistil and Apocarpous pistil (iii) Plumule and Radicle

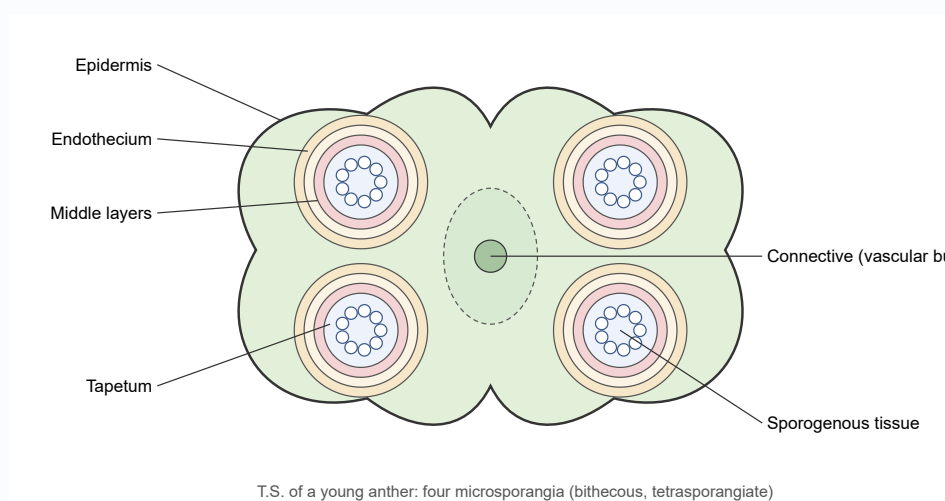
Solution

Perisperm: persistent, residual nucellus in some seeds (black pepper, beet)	Pericarp: wall of the fruit, formed from the wall of the ovary
Syncarpous pistil: many pistils (carpels) fused together (e.g. <i>Papaver</i>)	Apocarpous pistil: many pistils free from one another (e.g. <i>Michelia</i>)
Plumule: shoot tip of the embryonal axis (terminal part of the epicotyl); forms the future shoot	Radicle: root tip of the embryonal axis (terminal part of the hypocotyl); forms the future root

CBSE 2020 · 57/1/1 · Q13

3 marks

Draw a schematic transverse section of a mature anther of an angiosperm. Label its epidermis, middle layers, tapetum, endothecium, sporogenous tissue and the connective.

Solution

The anther is bilobed, with two microsporangia in each lobe (four in all). Each microsporangium has a wall of four layers: **epidermis**, **endothecium**, **middle layers** and **tapetum**, enclosing the **sporogenous tissue**. The lobes are joined by the **connective**, which has a vascular bundle.

CBSE 2020 · 57/1/1 · Q14

3 marks

Differentiate between wind pollinated and insect pollinated flowers.

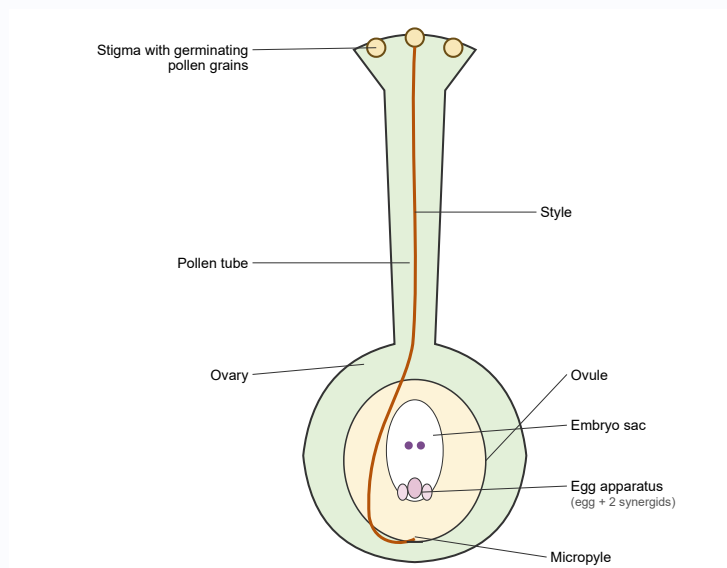
Solution

Wind-pollinated flowers	Insect-pollinated flowers
Pollen grains are light and non-sticky, produced in large numbers	Pollen grains are sticky (often covered with pollenkitt)
Stamens well exposed; stigma large and feathery to trap pollen	Stigma sticky; anthers and stigma placed to touch the insect
Flowers small, often packed in an inflorescence; usually a single ovule in each ovary	Flowers large, colourful, fragrant and rich in nectar (floral rewards)

CBSE 2020 · 57/2/1 · Q13

3 marks

Draw a longitudinal section of the pistil from a flowering plant, where pollination has occurred. Label the following: (a) Stigma showing germinating pollen grains (b) Style (c) Pollen tube reaching the micropyle of the ovule (d) Embryo sac (e) Components of the egg apparatus

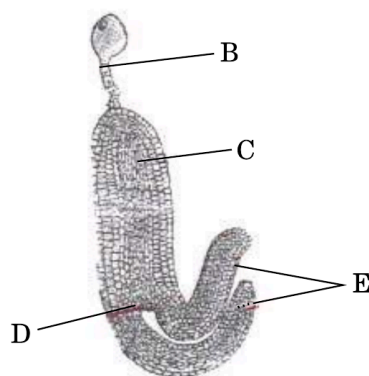
Solution

The egg apparatus consists of one egg cell and two synergids at the micropylar end of the embryo sac.

CBSE 2020 · 57/2/1 · Q14(b)

3 marks

(a) Identify the figure given below and also identify the parts B, C, D and E.



(b) State the function of E.

Solution

(a) It is a **mature dicot embryo** (e.g. *Capsella*). B – **suspensor**; C – **radicle**; D – **plumule**; E – **cotyledons**.

(b) Cotyledons **store food reserves** for the germinating seedling (as in legumes).

CBSE 2019 · 57/2/1 · Q13(a)

3 marks

When and where do tapetum and synergids develop in flowering plants? Mention their functions.

Solution

- **Tapetum:** develops during **microsporogenesis**, as the innermost wall layer of the **microsporangium (anther)**. Function: nourishes the developing pollen grains.
- **Synergids:** develop during **megagametogenesis** (formation of the embryo sac), at the micropylar end of the **embryo sac in the ovule (megasporangium)**. Function: their **filiform apparatus** guides the pollen tube into the synergid.

CBSE 2019 · 57/2/1 · Q13(b)

3 marks

Where are the following structures present in a male gametophyte of an angiosperm ? Mention the function of each one of them. (a) Germ pore (b) Sporopollenin (c) Generative cell

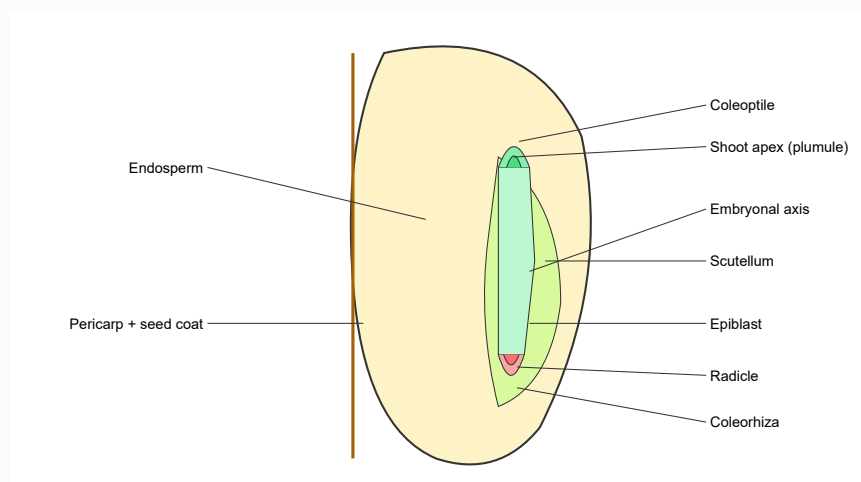
Solution

- (a) **Germ pore:** apertures in the **exine** of the pollen grain, where sporopollenin is absent. The pollen tube emerges through it.
- (b) **Sporopollenin:** forms the **exine** of the pollen grain. It is one of the most resistant organic materials, withstanding high temperatures, strong acids and alkalis, and no enzyme can degrade it. It protects the pollen grain.
- (c) **Generative cell:** the small spindle-shaped cell floating in the cytoplasm of the vegetative cell, **inside the pollen grain**. It divides to form the **two male gametes**.

CBSE 2019 · 57/2/1 · Q15(a)

3 marks

Draw L.S. of an embryo of grass and label its parts.

Solution

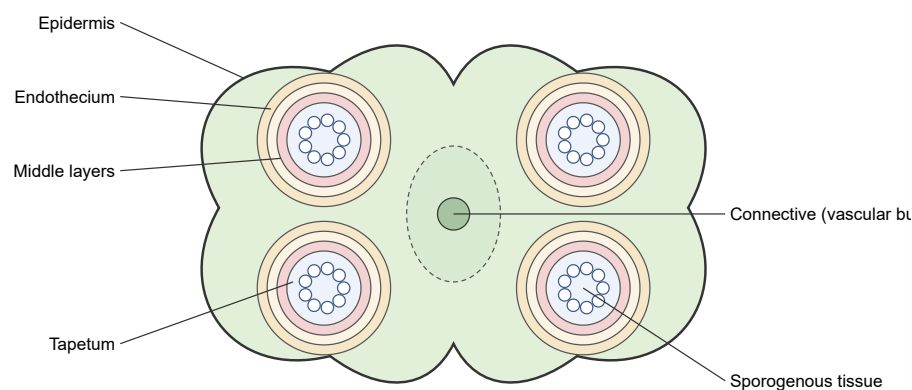
Parts: scutellum (the single cotyledon), coleoptile enclosing the shoot apex and leaf primordia, embryonal axis, radicle with root cap, coleorhiza (and epiblast); surrounded by endosperm.

CBSE 2019 · 57/3/1 · Q24

3 marks

Draw a T.S. of a young anther of an angiosperm. Label the different layers of the wall and write their functions.

Solution



T.S. of a young anther: four microsporangia (bithecous, tetrasporangiate)

Wall layers: **epidermis, endothecium, middle layers** (outer three) and **tapetum** (innermost).

Functions: the outer three layers perform the function of **protection** and help in **dehiscence** of the anther to release the pollen. The **tapetum nourishes** the developing pollen grains.

CBSE 2018 · 57/1 · Q13

3 marks

Differentiate between Parthenocarpy and Parthenogenesis. Give one example of each.

Solution

Parthenocarpy	Parthenogenesis
Formation of a fruit without fertilisation ; the fruit is seedless	Development of a new organism from an unfertilised egg
Example: banana (also grapes; induced by growth hormones)	Example: drones (male honey bees); also rotifers, turkey, some lizards

CBSE 2017 · 57/1 · Q11

3 marks

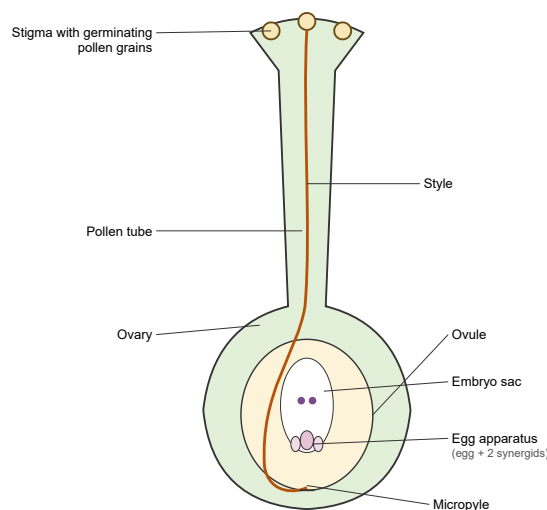
(a) Can a plant flowering in Mumbai be pollinated by pollen grains of the same species growing in New Delhi ? Provide explanations to your answer.

(b) Draw the diagram of a pistil where pollination has successfully occurred. Label the parts involved in reaching the male gametes to its desired destination.

Solution

(a) **Yes**, by **artificial hybridisation**. Pollen from the New Delhi plant can be collected and stored (in pollen banks by cryopreservation, if needed) and brought to Mumbai. The flower of the Mumbai plant is **emasculated** (anthers removed before dehiscence, if bisexual) and **bagged**. When its stigma is receptive, the desired pollen is dusted on it and the flower is re-bagged. Since both plants are of the same species, the pollen is compatible.

(b)



Parts involved: stigma (with germinating pollen), style through which the pollen tube grows, pollen tube, micropyle of the ovule, synergid with filiform apparatus, embryo sac.

CBSE 2016 · 57/1 · Q11(a)

3 marks

- (a) Name the organic material exine of the pollen grain is made up of. How is this material advantageous to pollen grain ?
- (b) Still it is observed that it does not form a continuous layer around the pollen grain. Give reason.
- (c) How are 'pollen banks' useful ?

Solution

- (a) **Sporopollenin**. It is one of the most resistant organic materials: it withstands high temperatures and strong acids and alkalis, and no enzyme degrades it. So it protects the pollen grain (and pollen is well preserved as fossils).
- (b) The exine has **germ pores**, where sporopollenin is absent. The pollen tube emerges through them during germination.
- (c) Pollen banks store pollen grains for years by **cryopreservation** in liquid nitrogen (-196°C). The stored pollen can be used in **crop breeding programmes** whenever needed.

5 marks: long answer

CBSE 2026 · 57/2/1 · Q31(a)

5 marks

- (i) Explain the role of stigma in pollen pistil interaction.
- (ii) Describe the post pollination events leading to double fertilization in angiosperms starting with 2-celled pollen grain.

Solution

- (i) The pistil (stigma) can recognise whether the pollen is of the right type (compatible) or the wrong type (incompatible). It accepts compatible pollen and promotes the post-pollination events. It rejects incompatible pollen by preventing germination on the stigma or pollen-tube growth in the style. The recognition depends on chemical interactions between the pollen and the pistil.
- (ii) • A compatible pollen grain germinates on the stigma and produces a **pollen tube** through a germ pore. The contents of the pollen grain move into the tube.

- The pollen tube grows through the tissues of the stigma and style and reaches the ovary. In a 2-celled pollen grain, the generative cell divides in the tube to form **two male gametes**.
- The tube enters the ovule through the **micropyle**, then enters one of the synergids through the **filiform apparatus**, which guides its entry.
- The pollen tube releases the two male gametes into the cytoplasm of the synergid.
- One male gamete fuses with the egg cell (**syngamy**), forming the diploid zygote.
- The other male gamete fuses with the two polar nuclei in the central cell (**triple fusion**), forming the triploid primary endosperm nucleus (PEN).
- Syngamy and triple fusion both occur in the embryo sac, so the process is called **double fertilisation**.

CBSE 2025 · 57/4/1 · Q31(a)

5 marks

- (i) Explain how does double fertilisation take place in a flowering plant.
 (ii) Write the fate of the products of double fertilization in these plants.

Solution

- (i) • The pollen tube enters one of the synergids through the filiform apparatus and releases two male gametes into its cytoplasm.
- One male gamete moves towards the egg cell and fuses with its nucleus. This is **syngamy**, and it forms the diploid **zygote**.
 - The other male gamete moves towards the two polar nuclei in the central cell and fuses with them. This is **triple fusion**, and it forms the triploid **primary endosperm nucleus (PEN)**; the central cell becomes the primary endosperm cell (PEC).
 - Two fusions, syngamy and triple fusion, take place in one embryo sac, so the process is called **double fertilisation**.
- (ii) • The **PEC** develops into the **endosperm** (triploid), which nourishes the developing embryo.
- The **zygote** develops into the **embryo**.
- (Also: the ovules mature into seeds, the ovary into the fruit, the integuments into the seed coats, and the synergids and antipodals degenerate.)

CBSE 2025 · 57/5/1 · Q33(a)

5 marks

- (i) Explain the structure of a typical monocotyledonous embryo of a flowering plant.
 (ii) How are multiple embryos formed in a citrus fruit ? What is the mechanism known as ?

Solution

- (i) • A monocot embryo has only **one cotyledon**. In the grass family it is called the **scutellum**, and it lies to one side (laterally) of the embryonal axis.
- At its lower end, the embryonal axis has the **radicle** and root cap, enclosed in an undifferentiated sheath called the **coleorhiza**.
 - The part of the axis above the level of attachment of the scutellum is the **epicotyl**. It has a shoot apex and a few leaf primordia, enclosed in a hollow foliar structure, the **coleoptile**.
- (ii) In citrus, some **nucellar cells** surrounding the embryo sac start dividing, protrude into the embryo sac and develop into embryos. So each ovule has many embryos besides the zygotic one.

The occurrence of more than one embryo in a seed is **polyembryony**, and the formation of these non-zygotic embryos is a form of **apomixis**.

CBSE 2024 · 57/1/1 · Q31(a)

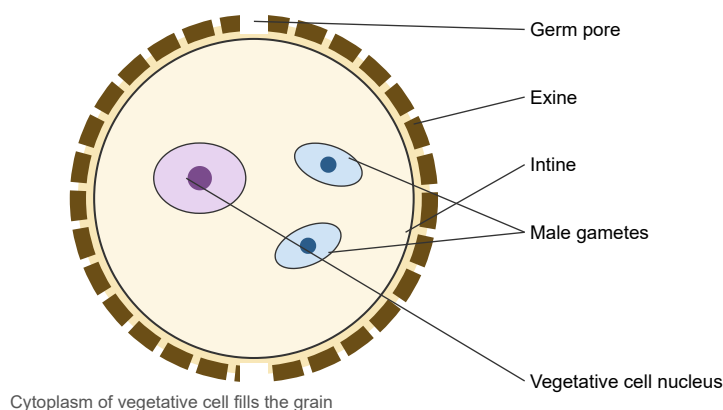
5 marks

- (i) Explain the development of male gametophyte in an angiosperm.
(ii) Draw a labelled diagram of a three-celled male gametophyte.

Solution

- (i) • Each **microspore mother cell** (pollen mother cell) of the sporogenous tissue undergoes **meiosis** to form a cluster of four microspores, the **microspore tetrad** (microsporogenesis).
• As the anther matures and dehydrates, the microspores separate and develop into pollen grains.
• The pollen grain is the male gametophyte. Inside it, the microspore nucleus divides by **mitosis** (asymmetric division) to form a large **vegetative cell** (with abundant food reserve and an irregular nucleus) and a small spindle-shaped **generative cell**, which floats in the vegetative cell's cytoplasm.
• In over 60% of angiosperms, pollen is shed at this 2-celled stage. In the rest, the generative cell divides mitotically into **two male gametes** before shedding (3-celled stage).

(ii)



CBSE 2024 · 57/2/1 · Q31(a)

5 marks

- (i) Explain the process of double fertilization in an angiosperm starting from the germination of pollen grains on the stigma, mentioning the ploidy of the end products formed at the end. State the role of synergids during the course of the process.
(ii) Why does the development of endosperm precede that of the embryo ?

Solution

- (i) • A compatible pollen grain germinates on the stigma and puts out a pollen tube, which grows down through the style to the ovary.
• The generative cell divides mitotically to form **two male gametes**.
• The pollen tube enters the ovule through the micropyle and enters one of the synergids, where it discharges the two male gametes.
• One male gamete (n) fuses with the egg (n): **syngamy**, forming the **diploid (2n) zygote**.
• The other male gamete (n) fuses with the two polar nuclei (secondary nucleus, 2n) in the central cell: **triple fusion**, forming the **triploid (3n) primary endosperm nucleus (PEN)**.

- Two fusions occur in one embryo sac, hence **double fertilisation**.

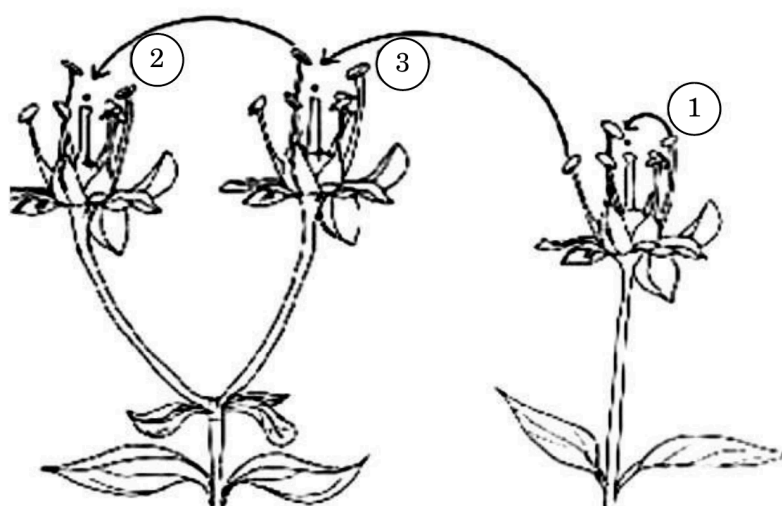
Role of synergids: the **filiform apparatus** at their micropylar tip guides the entry of the pollen tube into the synergid.

- (ii) The endosperm develops first so that the developing embryo gets **assured nutrition** from it.

CBSE 2023 · 57/1/1 · Q33(a)

5 marks

Study the diagram given below showing the modes of pollination. Answer the questions that follow.



- (i) The given diagram shows three methods of pollen transfer in plants. What are the technical terms used for pollen transfer methods '1', '2' and '3' ?
- (ii) How do the following plants achieve pollination successfully ? (1) Water lily (2) *Vallisneria*
- (iii) Flowering plants have developed many devices to avoid inbreeding depression. Explain one hereditary and one physiological device which helps plants to achieve this target.

Solution

- (i) 1 – **autogamy** (pollen to the stigma of the same flower); 2 – **geitonogamy** (to another flower of the same plant); 3 – **xenogamy** (to a flower of a different plant).

(ii) (1) Water lily: its flowers rise above the water surface and are pollinated by **insects or wind**, as in most land plants.

(2) *Vallisneria*: the female flower reaches the water surface on a long stalk. The male flowers or pollen grains are released onto the surface and carried passively by water currents, and some of them reach the female flowers and the stigma.

(iii) **Hereditary (genetic): self-incompatibility**, a genetic mechanism that stops pollen from the same flower (or other flowers of the same plant) from fertilising the ovules by inhibiting pollen germination or pollen-tube growth in the pistil.

Physiological: pollen release and stigma receptivity are **not synchronised**. Either the pollen is released before the stigma becomes receptive, or the stigma becomes receptive much before the pollen is released.

CBSE 2023 · 57/3/1 · Q33(b)

5 marks

- (i) Double fertilisation is an event unique to all flowering plants. Explain the process.
- (ii) Give a reason for the following : (1) A seed of an orange has many embryos. (2) Cashew is a false fruit but Guava is a true fruit.

Solution

(i) The pollen tube releases two male gametes into a synergid of the embryo sac.

• **Syngamy**: one male gamete fuses with the egg cell to form the diploid **zygote**.

• **Triple fusion**: the other male gamete fuses with the two polar nuclei in the central cell to form the triploid **primary endosperm nucleus**.

Two kinds of fusion take place in the same embryo sac, so it is called **double fertilisation**.

(ii) (1) **Polyembryony**: in citrus, some nucellar cells surrounding the embryo sac start dividing, protrude into the embryo sac and develop into embryos, in addition to the zygotic embryo.

(2) In cashew, the **thalamus** also contributes to fruit formation along with the ovary, so it is a false fruit. A guava develops only from the ovary after fertilisation, so it is a true fruit.

CBSE 2019 · 57/3/1 · Q25(a)

5 marks

- (a) Explain the role of stigma in pollen-pistil interactions.
- (b) Describe the post-pollination events leading to double fertilization in angiosperms, starting with a two-celled pollen grain.

Solution

(a) • The stigma is the **landing platform** for pollen grains.

• It carries on a continuous chemical dialogue with the pollen to recognise whether it is compatible (right type) or incompatible (wrong type).

• It **rejects incompatible pollen** by preventing its germination on the stigma or pollen-tube growth in the style.

• It **promotes** the germination and pollen-tube growth of compatible pollen, leading to fertilisation.

(b) • A compatible pollen grain germinates on the stigma and produces a pollen tube through a germ pore. The **vegetative cell** helps in the growth of the pollen tube.

• The pollen tube grows through the stigma and style, and the **generative cell divides into two male gametes** in the tube.

• The tube enters the ovule through the micropyle and a synergid through the filiform apparatus, releasing the two male gametes.

• One male gamete fuses with the egg cell to form the diploid **zygote**: **syngamy**.

• The other male gamete fuses with the two polar nuclei to form the triploid **primary endosperm nucleus**: **triple fusion**.

These two fusions together are called double fertilisation.

CBSE 2018 · 57/1 · Q24(a)

5 marks

- (a) Describe any two devices in a flowering plant which prevent both autogamy and geitonogamy.
 (b) Explain the events upto double fertilisation after the pollen tube enters one of the synergids in an ovule of an angiosperm.

Solution

- (a) • **Dioecy** (unisexual flowers on different plants, e.g. papaya): male and female flowers are on separate plants, so neither self- nor geitonogamous pollination is possible.
 • **Self-incompatibility**: a genetic mechanism that stops pollen from the same flower or other flowers of the same plant from fertilising the ovules, by inhibiting pollen germination or pollen-tube growth in the pistil.
 (b) • The pollen tube releases the **two male gametes** into the cytoplasm of the synergid.
 • One male gamete moves towards the egg cell and fuses with its nucleus (**syngamy**), forming the diploid **zygote**.
 • The other male gamete moves towards the two polar nuclei in the central cell and fuses with them (**triple fusion**), forming the triploid **primary endosperm nucleus (PEN)**; the central cell becomes the primary endosperm cell (PEC).
 Since two types of fusion take place in an embryo sac, the process is called **double fertilisation**.

CBSE 2017 · 57/1 · Q24(a)

5 marks

- (a) When a seed of an orange is squeezed, many embryos, instead of one are observed. Explain how it is possible.
 (b) Are these embryos genetically similar or different? Comment.

Solution

- (a) This is **polyembryony**, the occurrence of more than one embryo in a seed.
 In citrus (orange), some of the **nucellar cells** surrounding the embryo sac start dividing, protrude into the embryo sac and develop into embryos. These embryos form without fertilisation (a type of **apomixis**), in addition to the normal zygotic embryo.
 (b) The nucellar embryos are formed from the diploid nucellus of the mother plant by mitosis, without meiosis or fertilisation. So they are **genetically identical to the mother plant** (clones) and to each other. The zygotic embryo, formed by fertilisation, is genetically different.

CBSE 2016 · 57/1 · Q24(b)

5 marks

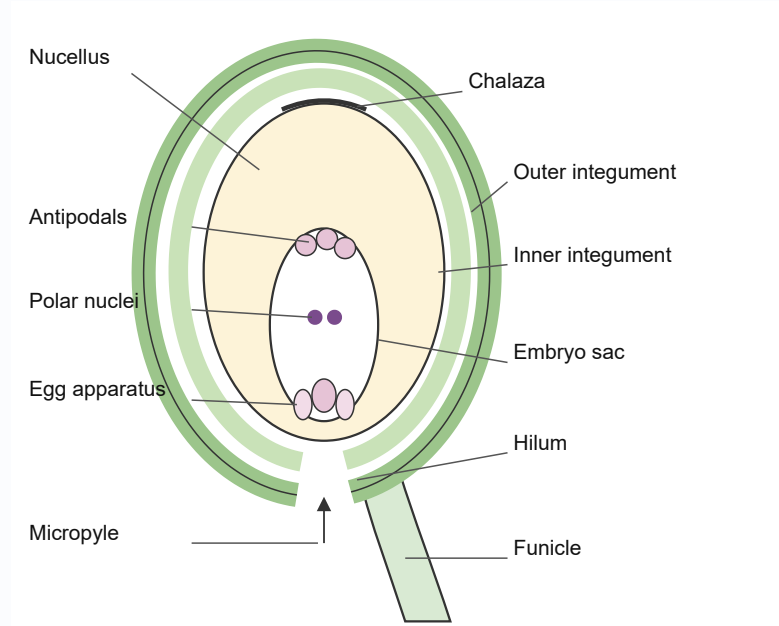
- (a) As a senior biology student you have been asked to demonstrate to the students of secondary level in your school, the procedure(s) that shall ensure cross-pollination in a hermaphrodite flower. List the different steps that you would suggest and provide reasons for each one of them.
 (b) Draw a diagram of a section of a megasporangium of an angiosperm and label funiculus, micropyle, embryo sac and nucellus.

Solution

- (a) • **Emasculation**: remove the anthers from the flower bud before they dehisce, using forceps.
 Reason: to prevent self-pollination.

- **Bagging:** cover the emasculated flower with a bag of butter paper. Reason: to prevent contamination of its stigma with unwanted pollen.
- **Dusting pollen:** when the stigma becomes receptive, dust it with pollen collected from the desired male parent. Reason: to make sure only the desired pollen pollinates it.
- **Rebagging:** cover the flower again. Reason: to protect it from other pollen and allow the fruit to develop.

(b)



CBSE BOARD PAPER

2026 · Q.P. Code 57/1/1

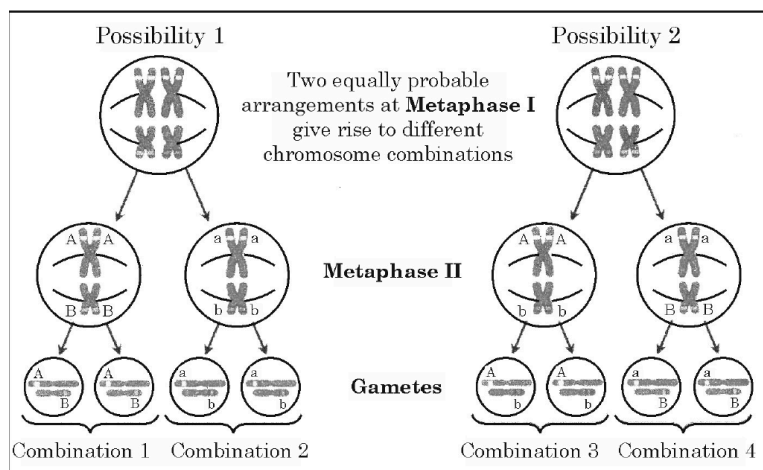
Time: 3 hours

Maximum marks: 70

Section A · Multiple choice and Assertion–Reason (1 mark each)

1. Identify the plant in which emasculation is not required for artificial hybridization. 1
 (A) Rice (B) Wheat
 (C) Pea (D) Papaya
2. Which of the following is not a component of immune system ? 1
 (A) Lymphocytes (B) Plasma Proteins
 (C) Red Blood Cells (D) Bone Marrow
3. Select the option that shows correct statements : 1
 (i) Corpus luteum secretes progesterone.
 (ii) Only FSH attains a peak level in middle of cycle.
 (iii) LH surge induces rupture of graafian follicle.
 (iv) Luteal phase of menstrual cycle is also called proliferative phase.
 (A) Only (ii) is correct. (B) (i) and (iii) are correct.
 (C) Only (iv) is correct. (D) (ii) and (iv) are correct.
4. Select the mismatched pair : 1
 (A) Mega diversity countries in the world – 12 (B) Genetically different strains of rice in India – Less than 1000
 (C) Robert Mays estimation on global species diversity – 7 million species worldwide (D) Zoological parks – Ex-situ conservation
5. Pomato was produced by fusing protoplasts of 1
 (A) Tomato and Potato (B) Pomegranate and Tomato
 (C) Pomegranate and Potato (D) Pomegranate, Potato and Tomato
 not in 2026-27 syllabus
6. In an ecosystem, different species occupy different levels and vertical distribution is called 1
 (A) Stratification (B) Layering
 (C) Fragmentation (D) Population
7. Which of the following sacred groves is found in Meghalaya ? 1
 (A) Jaintia hills (B) Bastar
 (C) Chanda (D) Sarguja

8. In the following figure, two ways of pairing of two homologous pairs of chromosomes are shown. Which of the following phenomena is expressed ?



- (A) Linkage of genes
(B) Independent assortment of genes
(C) Multiple alleles
(D) Incomplete dominance

9. Match Column-I with Column-II and choose the correct option :

Column-I	Column-II
a. Biolistic gun	i. Bacterial cell
b. Chitinase	ii. Tumour inducing
c. Ti	iii. Animal cell
d. Ca^{++}	iv. Fungal cell
	v. Plant cell

- (A) i ii iii iv
(B) ii v i iii
(C) v iv ii i
(D) v i iv ii

10. The idea of use and disuse of organs for evolution of organism was proposed by

- (A) Charles Darwin
(B) Thomas Malthus
(C) Hugo De Vries
(D) Lamarck

11. Which of the following statements about plasmids is incorrect ?

- (A) Plasmids have the ability to replicate within the bacterial cell.
(B) Their replication is controlled by chromosomal DNA.
(C) They are autonomously replicating circular extra-chromosomal DNA.
(D) They often carry antibiotic resistant genes.

12. Which connective tissue connects ovary to pelvic wall and uterus ?

- (A) Tendons
(B) Ligaments
(C) Cartilage
(D) Bone

- 13.** Assertion (A) : The population of melanized moths increased in industrial areas after Industrial Revolution. 1
Reason (R) : In Industrial environment lichen covered trees were replaced by soot-covered trees offering better camouflage to dark coloured moths.
- (A) Both A and R are true and R is the correct explanation of A. (B) Both A and R are true but R is not the correct explanation of A. (C) A is true but R is false. (D) A is false but R is true.
- 14.** Assertion (A) : The milk produced by transgenic cow 'Rosie' was nutritionally more balanced product for human babies than natural cow milk. 1
Reason (R) : It was human protein enriched milk containing human alpha lactaglobulin.
- (A) Both A and R are true and R is the correct explanation of A. (B) Both A and R are true but R is not the correct explanation of A. (C) A is true but R is false. (D) A is false but R is true.
- 15.** Assertion (A) : Flocs are masses of bacteria associated with fungal filaments in secondary treatment of sewage. 1
Reason (R) : Flocs help in digestion of solid waste by anaerobic respiration.
- (A) Both A and R are true and R is the correct explanation of A. (B) Both A and R are true but R is not the correct explanation of A. (C) A is true but R is false. (D) A is false but R is true.
- 16.** Assertion (A) : In terrestrial ecosystem much larger fraction of energy flows through grazing food chain. 1
Reason (R) : Grazing food chain may be connected to Detritus food chain at some levels.
- (A) Both A and R are true and R is the correct explanation of A. (B) Both A and R are true but R is not the correct explanation of A. (C) A is true but R is false. (D) A is false but R is true.

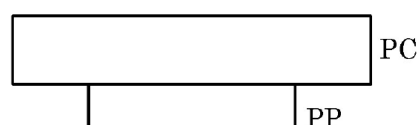
Section B · Very short answer (2 marks each)

- 17.** (a) Define Humoral immune response. 2
(b) Name any two types of antibodies found to give humoral immune response in humans.
- 18.** (a) (i) How does a farmer use dormancy of seed to his advantage ? 2
(ii) Differentiate between pea seed and castor seed.
- OR**
- (b)** Identify the stage of follicle where primary oocyte undergoes first meiotic division. Also mention the products of this division. 2
- 19.** Study the sequence of bases in a DNA molecule that is shown below and answer the questions. 2
5' – GAATTC – 3'
3' – CTTAAG – 5'
- (a) What are such sequences called ? Name the enzyme used that recognises such nucleotide sequences.
(b) How do these enzymes function ?

20. (a) Analyse the following two cases of sex determination in different organisms :
 Case I : Males have (XO) sex chromosomes and females have two copies of same sex chromosome (XX).
 Case II : Females have two different sex chromosomes (ZW) and males have two copies of same sex chromosome (ZZ).
 Identify the type of heterogamety in each case, giving one example of each.

OR

- (b) (i) Differentiate between a DNA and RNA nucleotide.
 (ii) Name the two types of bonds present within a single nucleotide.
21. (a) Given below is a pyramid found in an ecosystem, where each bar represents the standing crop available in the trophic level.



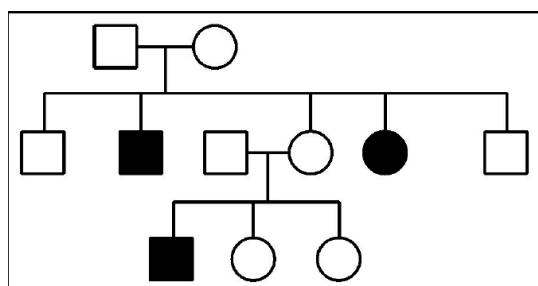
- (i) Identify the kind of pyramid and with the help of an example explain the conditions where this kind of pyramid is possible in nature.
 (ii) Write any two limitations of ecological pyramids.

OR

- (b) In an ecosystem there was loss of biodiversity due to some project in that area.
 (i) How will biodiversity be affected ? (2 points)
 (ii) List two major causes of loss of biodiversity.

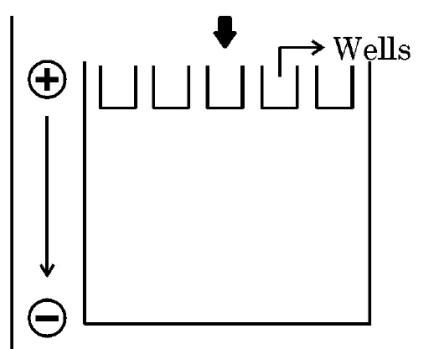
Section C · Short answer (3 marks each)

22. (a) Do all pollen grains remain viable for the same length of time ? Support your answer with two suitable examples.
 (b) How are pollen grains stored in pollen banks ?
23. (a) What is pedigree analysis ? Mention its importance in human genetics. (2 pts.)
 (b) Analyse the following pedigree and write the (i) Pattern of inheritance. (ii) Give one example of disease showing such an inheritance pattern.

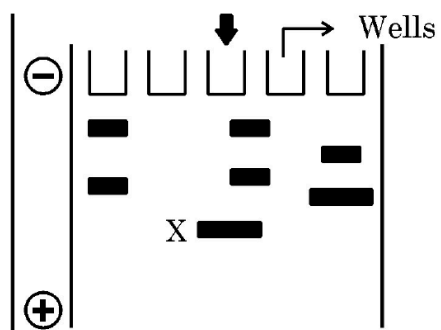


24. (a) How is Hardy-Weinberg expression ($p^2 + 2pq + q^2 = 1$) derived ?
 (b) List any two factors that disturb the genetic equilibrium.
25. Draw a neat diagram of megasporangium of an angiosperm and label any six parts.

26. (a) Mention the scientific name of the source plant and the part from which opioids are extracted. 3
 (b) How are morphine and heroin related ? Mention the effect each one of them has on human body.
27. A farmer grew two varieties of corn crop in field A and B. He grew normal corn crops in field A and GM corn crops in field B. He observed that corn borers attacked only in field A. To control it, spores of Bt were sprayed on field A. 3
 (a) Name the gene in the spores responsible for control of pest.
 (b) What effect will the spores of Bt have on insect pest ?
 (c) How has corn plants of field B developed resistance against this pest ? Explain.
28. Observe the given picture carefully. A mixture of DNA with fragments ranging from 100 base pairs to 1800 base pairs were separated by electrophoresis on agarose gel with the following arrangement : 3



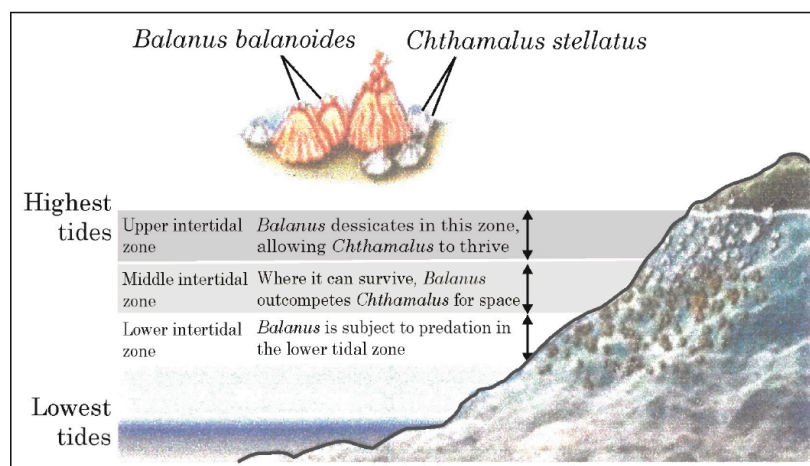
- (a) What result will be obtained in staining with ethidium bromide ? Explain with reasons.
 (b) The above setup was modified as shown below and a band with 100 base pairs was obtained at X.



What changes were made to the previous design to get a band at 'X'. Why did the band appear at 'X' ?

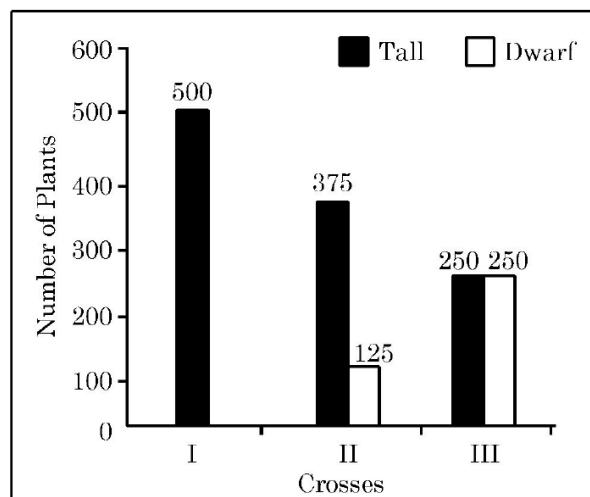
Section D · Case-based (4 marks each)

29. The diagram below shows the distribution of two barnacle species, *Chthamalus* and *Balanus* on a rocky sea shore. When *Balanus* is experimentally removed, *Chthamalus* expands its range in lower intertidal zone.



- (a) Identify and define the ecological phenomenon demonstrated by this observation. (1)
OR
(a) State the principle that explains the elimination of one species. (1)
(b) Two different species can compete for the same resource. Give another example of it. (1)
(c) How do species avoid competition in nature? Explain with an example. (2)

30. A student performed some crosses in plants and represented the result in the form of bar graphs as shown below. Each graph displays the phenotypic proportion of the progeny. Study the graphs and answer the questions :



- (a) What can you infer about the genotype of parents in crosses I and II? (1)
OR
(a) Which genetic cross is represented by these crosses? (1)
(b) Looking at bar graph of cross III, identify the type of cross performed and its importance in genetics. (2)
(c) What conclusion can you draw from the results of bar graphs of crosses I and II? Name the genetic principle illustrated. (1)

Section E · Long answer (5 marks each)

31. (a) Trace the events from fertilization till implantation of blastocyst in human female. Also mention the site where fertilization takes place. 5

OR

(b) (i) Case studies of some couples are given below. They were not able to have kids even though the parents were not taking any precautions. They also do not wish to adopt a child or take the help of donors. Study these cases and suggest an appropriate Assisted Reproductive Technology that could help them. 5

Case I – Female – Normal Reports; Male – Normal sperms but no connection between epididymis and vas deferens.

Case II – Female – Normal eggs but Fallopian tube blocked. Male – Normal sperms. Male reports are normal.

Case III – Female – Normal Reports. Male – Low sperm count with less motility.

(ii) Copper releasing intrauterine devices are very effective and popular contraceptive devices. Name any two copper releasing IUDs. Write two reasons that make them effective contraceptives.

32. (a) (i) Watson and Crick's discovery of double helical structure was based on which two findings. Also mention the name of the scientists associated with these findings. 5
(ii) Write down the salient features of double helix structure of DNA (any three points).

OR

(b) Given below is a stretch of DNA showing the coding strand of structural gene of transcription unit. 5

5' - ATG ACC GTA TTT TCT GTA GTG CCC GTA CTT CAG GCA TTA 3'

(i) Write the corresponding template strand and m-RNA strand that will be transcribed along with its polarity.

(ii) If GUA of transcribed mRNA is an intron, then depict the sequence involved in formation of mRNA / mature / processed hnRNA strand : (1) In a bacterium (2) In humans

(iii) How many amino acids the resulting polypeptide will have after the process of translation in humans ?

33. (a) (i) Name the protozoan species that is responsible for causing the most serious and even fatal malarial disease. 5
(ii) Name the host in which the parasite completes its sexual stages and explain the changes taking place.
(iii) How does the parasite damage the human body after entering the blood stream ?
(iv) Suggest two effective preventive measures to control the spread of this disease in endemic regions.

OR

(b) (i) What are bio-fertilizers ? 5

(ii) Name the different types of microorganisms used as bio-fertilizers in organic farming and explain how each contributes to soil fertility.

(iii) Write two advantages of using bio-fertilizers over chemical fertilizers.

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Q1 Answer: (D) Papaya

Papaya is dioecious: male and female flowers are on separate plants, so the female flower has no anthers to remove. It only needs bagging before pollination. Rice, wheat and pea have bisexual flowers and must be emasculated.

Q2 Answer: (C) Red Blood Cells

RBCs carry oxygen and have no role in immunity. Lymphocytes, antibodies (plasma proteins) and the bone marrow (a primary lymphoid organ) are all parts of the immune system.

Q3 Answer: (B) (i) and (iii) are correct.

(ii) is wrong: both LH and FSH peak in mid-cycle. (iv) is wrong: the follicular phase is the proliferative phase, while the luteal phase is the secretory phase.

Q4 Answer: (B)

India has more than 50,000 genetically different strains of rice, not fewer than 1000.

Q5 Answer: (A) Tomato and Potato

Pomato is a somatic hybrid made by fusing the protoplasts of tomato and potato.

Q6 Answer: (A) Stratification

For example, in a forest, trees occupy the top layer, shrubs the second and herbs and grasses the bottom layers.

Q7 Answer: (A) Jaintia hills

The Khasi and Jaintia hills are in Meghalaya. Bastar, Chanda and Sarguja are in Madhya Pradesh and Chhattisgarh.

Q8 Answer: (B) Independent assortment of genes

The two homologous pairs line up independently of each other at metaphase I. This gives four equally likely gene combinations in the gametes (AB, ab, Ab, aB), which is Mendel's law of independent assortment.

Q9 Answer: (C) a – v, b – iv, c – ii, d – i

A biolistic (gene) gun shoots DNA-coated gold or tungsten particles into plant cells. Chitinase breaks the fungal cell wall. The Ti plasmid is the tumour-inducing plasmid of *Agrobacterium*. Divalent Ca^{2+} ions make bacterial cells competent to take up DNA.

Q10 Answer: (D) Lamarck

Lamarck said that organs that are used develop and those not used degenerate, and that these acquired changes are inherited (e.g. the giraffe's long neck).

Q11 Answer: (B)

Plasmids replicate autonomously, independent of the chromosomal DNA, because each has its own origin of replication (ori).

Q12 Answer: (B) Ligaments

Each ovary is held to the pelvic wall and uterus by ligaments.

Q13 **Answer: (A) Both A and R are true and R is the correct explanation of A.**

On soot-darkened bark, dark moths were hidden from predatory birds and white moths were picked off. Natural selection therefore increased the number of melanised moths.

Q14 **Answer: (C) A is true but R is false.**

Rosie's milk was more balanced for human babies, but the human protein it contained was **alpha-lactalbumin** (2.4 g per litre), not "alpha lactaglobulin".

Q15 **Answer: (C) A is true but R is false.**

Flocs grow in the aeration tank, where air is pumped in. They consume the organic matter by **aerobic** respiration and so lower the BOD. Anaerobic digestion happens later, in the sludge digester.

Q16 **Answer: (D) A is false but R is true.**

In terrestrial ecosystems a much larger fraction of energy flows through the **detritus** food chain. The two chains are linked, because dead organisms of the grazing chain become detritus.

Q17 (a) The humoral immune response is the antibody-mediated response. B-lymphocytes produce antibodies that circulate in the blood and lymph (body humours) and fight pathogens.
(b) Any two: **IgA, IgM, IgE, IgG.**

Q18(a) (i) Dormant, dehydrated seeds can be stored for a long time. The farmer stores them and sows them to raise the crop in the next season (they are also used as food).
(ii)

Pea seed	Castor seed
Non-albuminous (non-endospermic)	Albuminous (endospermic)
The endosperm is fully used up during embryo development; no endosperm is left	A part of the endosperm is left in the mature seed

Q18(b) The primary oocyte completes its first meiotic division inside the **tertiary follicle** (as it matures into the Graafian follicle).
The products are a large haploid **secondary oocyte** and a tiny **first polar body**.

Q19 (a) **Palindromic nucleotide sequences:** they read the same on both strands when read in the same direction (5' → 3'). The enzyme is a **restriction endonuclease, EcoRI**.
(b) The restriction endonuclease scans the DNA, binds to its specific palindromic recognition sequence and cuts each strand at a specific point between the same two bases (EcoRI cuts between G and A). The cuts are a little away from the centre of the palindrome, so single-stranded overhangs called **sticky ends** are left on each strand.

Q20(a) Case I: **male heterogamety** (the male makes two kinds of sperm, with and without X). Example: grasshopper (many insects).
Case II: **female heterogamety** (the female makes two kinds of eggs, Z and W). Example: birds (hen).

Q20(b) (i)

DNA nucleotide	RNA nucleotide
Sugar is deoxyribose	Sugar is ribose
Base is A, G, C or thymine	Base is A, G, C or uracil

(ii) **N-glycosidic linkage** (between the nitrogen base and the 1' C of the pentose sugar) and **phosphoester linkage** (between the phosphate and the 5' OH of the sugar).

Q21(a) (i) It is an **inverted pyramid of biomass**: the primary consumers (PC) have a larger standing crop than the producers (PP). It is seen in the sea, where a small standing crop of phytoplankton supports a large standing crop of zooplankton or fish. The phytoplankton reproduce very fast, so their small biomass at any moment can feed a larger consumer biomass.

(ii) Any two:

- They do not account for a species that belongs to two or more trophic levels.
- They assume a simple food chain and cannot show a food web.
- Saprophytes (decomposers) are not shown, though they play a vital role.

Q21(b) (i) Any two: plant production declines; the ecosystem's resistance to disturbances such as drought falls; variability increases in ecosystem processes such as plant productivity, water use and pest and disease cycles.

(ii) Any two of the "evil quartet": **habitat loss and fragmentation, over-exploitation**, alien species invasions, co-extinctions.

Q22 (a) **No**. The period of viability varies a lot and depends on temperature and humidity.

- In rice and wheat (cereals), pollen loses viability within **30 minutes** of release.
- In some members of Rosaceae, Leguminosae and Solanaceae, pollen stays viable for **months**.

(b) Pollen is stored by **cryopreservation** in liquid nitrogen at **-196 °C** and used later in crop breeding programmes.

Q23 (a) Pedigree analysis is the study of how a trait is inherited over several generations of a family, using a family tree drawn with standard symbols.

Importance: controlled crosses are not possible in humans, so it is used to trace the inheritance of a trait, abnormality or disease. It also helps to predict the chance of a genetic disorder in future generations (genetic counselling).

(b) (i) **Autosomal recessive**. Two unaffected parents have affected children, so the trait is recessive. An affected daughter has an unaffected father, which rules out X-linked recessive inheritance.

(ii) Sickle-cell anaemia (or thalassemia, phenylketonuria).

Q24 (a) In a population, the frequencies of the alleles of a gene stay constant across generations, and their sum is 1. Let alleles A and a have frequencies p and q, so $p + q = 1$.

The chance that allele A is present on both homologous chromosomes of a diploid individual is $p \times p = p^2$, the frequency of AA. Similarly $aa = q^2$, and $Aa = 2pq$ (A from the father and a from

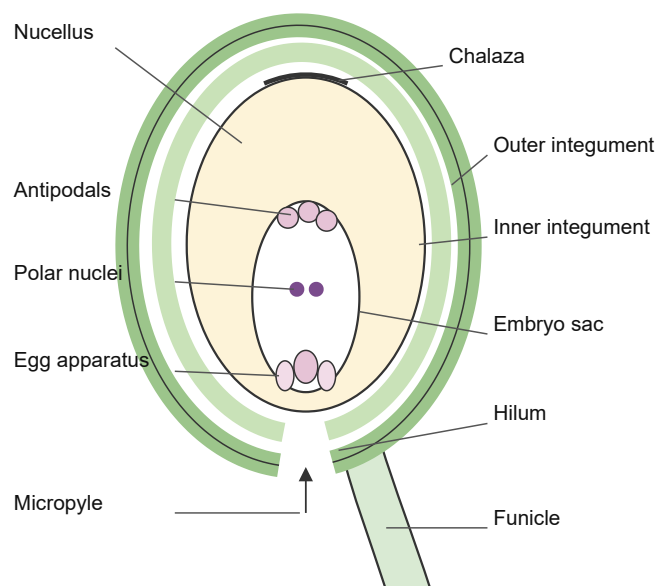
the mother, or the reverse).

$$\text{So } (p + q)^2 = p^2 + 2pq + q^2 = 1.$$

(b) Any two: gene migration (gene flow), genetic drift, mutation, genetic recombination, natural selection.

Q25

The megasporangium is the ovule (anatropous ovule, L.S.):



Any six labels: funicle, hilum, micropyle, outer integument, inner integument, nucellus, chalaza, embryo sac (egg apparatus, polar nuclei, antipodals).

Q26

(a) The poppy plant, *Papaver somniferum*. Opioids are extracted from the **latex** of the plant.

(b) Heroin (smack) is **diacetylmorphine**, made by acetylation of morphine.

Morphine is a very effective sedative and painkiller, useful in patients who have undergone surgery.

Heroin is a depressant: it slows down body functions.

Q27

(a) **cry IAb** (it controls corn borer).

(b) The insect larvae eat the Bt spores along with the leaves. The Bt toxin is an inactive protoxin; the alkaline pH of the insect gut activates it. The active toxin binds to the midgut epithelial cells and makes pores, so the cells swell and burst (lyse) and the insect dies.

(c) The *cry* gene of *Bacillus thuringiensis* was transferred into the corn plants of field B (Bt corn). These GM plants make the Bt toxin themselves, so a corn borer feeding on them is killed.

Q28 (a) **No bands will be seen** in the gel. DNA is negatively charged and moves towards the anode (+). Here the wells are at the anode end, so the DNA does not move through the gel towards the cathode and no fragments are separated.

(b) The electrodes were **interchanged**: the wells are now at the cathode (–) end and the anode (+) is at the far end.

Agarose acts as a sieve, so fragments separate by size. The smallest fragment moves fastest and farthest towards the anode. So the 100 bp fragment, the smallest in the mixture, forms the band at X.

Q29 (a) **Competitive release**. A species whose distribution is restricted to a small area because a competitively superior species is present expands its range when the superior competitor is removed.

OR (a) **Gause's competitive exclusion principle**: two closely related species competing for the same resources cannot coexist indefinitely; the competitively inferior one is eventually eliminated.

(b) In shallow South American lakes, visiting flamingos and resident fishes compete for their common food, zooplankton. (Also: *Abingdon tortoise* and goats on the Galapagos.)

(c) By **resource partitioning**: competing species choose different times for feeding or different foraging patterns. Example: MacArthur showed that five closely related species of warblers living on the same tree avoided competition and coexisted because they foraged in different parts of the tree.

Q30 (a) Cross I (all 500 tall): at least one parent is homozygous tall, $TT \times TT$ or $TT \times tt$ (or $TT \times Tt$).
Cross II (375 tall : 125 dwarf = 3 : 1): both parents are heterozygous, **$Tt \times Tt$** .

OR (a) **Monohybrid crosses** (one character, plant height, is studied).

(b) Cross III gives 250 tall : 250 dwarf = 1 : 1, so it is a **test cross** ($Tt \times tt$).

Importance: crossing an organism showing the dominant phenotype with the recessive parent tells whether its genotype is homozygous (TT , all tall) or heterozygous (Tt , 1 : 1).

(c) Tall is dominant over dwarf: in cross I dwarf does not appear, and in cross II it reappears only in a quarter of the progeny. The principle is the **law of dominance**.

Q31(a) Site: the ampullary region of the fallopian tube (ampullary–isthmic junction).

1. A sperm contacts the zona pellucida of the secondary oocyte. This changes the membrane, which blocks the entry of other sperms.

2. Entry of the sperm makes the secondary oocyte complete meiosis II, giving a haploid ovum (ootid) and a second polar body.

3. The haploid nuclei of the sperm and the ovum fuse to form a diploid **zygote**.

4. The zygote divides by mitosis (**cleavage**) while moving through the isthmus of the oviduct towards the uterus, forming 2, 4, 8, 16 daughter cells called **blastomeres**.

5. The embryo with 8 to 16 blastomeres is the **morula**.

6. The morula keeps dividing and becomes the **blastocyst**. Its blastomeres are arranged into an outer layer, the **trophoblast**, and an **inner cell mass**.

7. The trophoblast layer attaches to the endometrium; the inner cell mass later forms the embryo.

8. The uterine cells then divide rapidly and cover the blastocyst, which becomes embedded in the endometrium. This is **implantation**, and it leads to pregnancy.

Q31(b) (i) Case I: the sperms cannot reach the ejaculate, so sperms are collected from the epididymis and used in **IVF followed by embryo transfer (ZIFT/IUT)** (or artificial insemination, IUI).

Case II: the eggs cannot reach the site of fertilisation, so **IVF followed by intra-uterine transfer (IUT)** of the embryo (with more than 8 blastomeres) into the uterus.

Case III: **ICSI** (intracytoplasmic sperm injection: a sperm is injected directly into the ovum), or artificial insemination (IUI) using the husband's semen collected and concentrated.

(ii) Copper-releasing IUDs: **CuT, Cu7, Multiload 375** (any two).

Why effective:

- They increase phagocytosis of sperms within the uterus.
- The Cu ions released suppress sperm motility and the fertilising capacity of sperms.

Q32(a) (i) • The **X-ray diffraction data** of DNA produced by **Maurice Wilkins and Rosalind Franklin**.
• **Chargaff's rules** (Erwin Chargaff): in double-stranded DNA, $A = T$ and $G \equiv C$, so the ratios A/T and G/C are constant and equal to one.

(ii) Any three:

- DNA is made of two polynucleotide chains. Sugar and phosphate form the backbone and the bases project inwards.
- The two chains have **antiparallel polarity** ($5' \rightarrow 3'$ and $3' \rightarrow 5'$).
- The bases of the two strands pair through hydrogen bonds: A with T (two H-bonds) and G with C (three H-bonds). A purine always pairs with a pyrimidine, so the distance between the strands stays uniform.
- The two chains are coiled in a **right-handed** helix. The pitch is 3.4 nm with about 10 bp per turn, so adjacent base pairs are about 0.34 nm apart.
- The plane of one base pair stacks over the other, which adds to the stability of the helix.

Q32(b) (i) Template strand: **3' – TAC TGG CAT AAA AGA CAT CAC GGG CAT GAA GTC CGT AAT – 5'**
mRNA (same as the coding strand, with U for T): **5' – AUG ACC GUA UUU UCU GUA GUG CCC GUA CUU CAG GCA UUA – 3'**

(ii) (1) In a bacterium, genes are not split and there is no splicing; the mRNA is used as it is:

5' – AUG ACC GUA UUU UCU GUA GUG CCC GUA CUU CAG GCA UUA – 3'

(2) In humans, the hnRNA is spliced (the three GUA introns are removed), capped (methyl guanosine triphosphate at the 5' end) and tailed (poly-A at the 3' end):

5' – ^mGppp – AUG ACC UUU UCU GUG CCC CUU CAG GCA UUA – AAAA...(poly A tail) – 3'

(iii) The mature mRNA has 10 codons (AUG ... UUA), so the polypeptide has **10 amino acids**.

Q33(a) (i) *Plasmodium falciparum* (causes malignant malaria).

(ii) The **female Anopheles mosquito**.

- The mosquito picks up the gametocytes when it bites an infected person.
- Fertilisation and development take place in the mosquito's gut.
- The sporozoites formed migrate to the salivary glands, from where they are passed on at the next bite.

(iii) The sporozoites reach the liver and multiply asexually in the liver cells. The parasites then attack the red blood cells and multiply there, causing the RBCs to rupture. The rupture releases a toxic substance, **haemozoin**, which causes chills and high fever recurring every three to four days.

(iv) Any two: avoid stagnant water around homes; clean household coolers regularly; use mosquito nets; introduce larvivorous fish such as *Gambusia* in ponds; spray insecticides in ditches and drainage areas; fit wire mesh on doors and windows.

Q33(b) (i) Biofertilisers are organisms that enrich the nutrient quality of the soil. The main sources are bacteria, fungi and cyanobacteria.

(ii) • **Bacteria:** *Rhizobium* forms root nodules on leguminous plants and fixes atmospheric nitrogen into organic forms used by the plant. *Azospirillum* and *Azotobacter* are free-living in the soil and also fix atmospheric nitrogen.

• **Fungi:** fungi of the genus *Glomus* form mycorrhiza with plant roots. The fungus absorbs phosphorus from the soil and passes it to the plant. Such plants also resist root-borne pathogens, tolerate salinity and drought, and grow better overall.

• **Cyanobacteria:** autotrophic microbes such as *Anabaena*, *Nostoc* and *Oscillatoria* fix atmospheric nitrogen. They are important biofertilisers in paddy fields and also add organic matter to the soil.

(iii) Any two: they do not pollute the soil or ground water; they are cheap and renewable; they conserve beneficial soil microbes; they do not harm human health. Chemical fertilisers do the opposite.



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